THE TELEGRAPHIC JOURNAL.
VOL. VI.—NO. 129.

TELEGRAPHISTS AT FOREIGN STATIONS.

WE publish in this number the unpersonal portions of a lengthy communication which we have received from a "West Indian Telegraphist." We have published it, not from any desire to ventilate a particular grievance, but in the belief that some of its statements may have a bearing on the submarine telegraph service in general which may be productive of good. Whether our correspondent be a "man with a grievance" or not, we do not know; but we think that there is a great deal of truth and good sense in parts of his letter. At any rate he has a right to be heard, and our columns are always open as a medium of expression for telegraph *employés*.

We have in a former article treated of several points in the management of the submarine service which are indicated by a "West Indian Telegraphist." It is our intention at present to confine ourselves to a consideration of the state of comfort and morality which exists at telegraph stations abroad. In too many cases these blessings are most conspicuous by their absence.

A young operator entering the submarine telegraph service at once becomes the tool of his company, and receives orders to betake himself to some foreign station. Arrived there he goes into quarters with the rest of the clerks, and duly takes his eight hours' shift of signalling. The company provide his quarters, which are sometimes even wretched, if not beastly, although in general they are tolerably comfortable as far as the needs of mere animal existence—shelter, meals, and sleep—are concerned. The company also exact their stated amount of office routine from him; but here their solicitation for his welfare too frequently ends. The youth is left to seek his own amusements and recreation. He finds his bare quarters dull, the jokes of his companions are stale, time hangs heavy on his hands; so he goes out into the streets to smoke cigarettes, or take drinks at a *café* or *alcazar*. His social circle is of the smallest, if a real social circle exists for him at all; so in default of something better he seeks the female companionship which the streets never fail to offer. Severed from home, and all the upholding ties of kindred, deprived of good literature, pure society, and sometimes even of the church, his situation and prospects forbidding marriage, his work mechanical routine, himself the machine of a company, the unimportant limb of a system, feeling himself unsettled and a nomad, can it be wondered at that he yields himself to the influences around him, and lapses into motiveless ease and immorality?

We think that, if there be any remedy for the discomforts and immorality of foreign telegraph stations, it should proceed from the directory of the company and permeate downwards. It is very unlikely that the needed reform will emanate from the clerks themselves and spread upwards. It is high time that the management of telegraph companies ceased to regard their *employés* as mere manipulating instruments. This iron doctrine of our utilitarian times will not pay in the long run. If operators are treated with the consideration due to gentlemen, they are the more likely to prove such, and the resulting gain in harmony and good feeling is certain to prove more profitable to the company in the end. The directors of a company, and the superintendents under them, and by their orders, ought to see that the clerks are not only housed and fed, but they should take pains to provide wholesome and improving amusements also. Housing and feeding are the lowest essentials of life; and a telegraph company, sending young men and youths abroad to strange and out-of-the-way places and detaining them, should recognise that it takes upon itself a charge of far more moment than food and shelter. A life of this kind is exceptionally trying to the moral character of any man, and especially young men, some of whom are not so wise as they might be, and it is right that the company should do what is in their power to ameliorate its dangers. Some companies treat their servants better in this respect than others. Billiard tables are provided at some stations, and one or two periodicals circulated. Our plea is for something more elevating than billiard tables. Billiard tables are very well so far, but they are not enough, although to say so may astound the directorial mind to a degree only paralleled in the case of Mr. Bumble when the audacious Oliver Twist asked for more soup. Telegraph directors may find it difficult to believe that a telegraph operator can possibly require amusement of a higher kind than billiards; but such is the hard fact, nevertheless, and it must be faced. Pure literature and family society are, next to the church, the two most potent safeguards for a youth against the easy descent into immorality. If the directory of a telegraph company would interest itself in this subject, and see that a good, if small, library was provided at each station, and that the intercourse of clerks with the available good society of the place was cordially promoted, we feel sure that good would come of it. A literary and debating society, under the presidency of the superintendent,

and a corps of experimenters, would also tend to breathe life and freshness into the noxious vapours of jealousy, discontent, and apathy, which too commonly form the social atmosphere of a station as things are at present. We are of opinion, too, that some provision should be made for enabling operators to marry—a consummation quite discountenanced by the exigencies of the existing *régimes*. To effect this the more easily, only the younger men might be sent to outlandish and desert stations, the married operators being allowed to stay in towns and cities. A prospect of this kind before an operator would not fail, we think, to make him more contented with his lot, to inspirit him in his career, and to improve his character.

We have sufficient faith in the directors of the companies as to believe that it is only necessary to make them aware of the deficiencies of their station arrangements and the real needs of their servants, to secure measures of remedy from them. Unfortunately they are so placed as not to see for themselves what is taking place at their stations. Occasionally a pilgrimage is made by some of them through the latter; but it is not difficult to understand that in this way they see matters at their best, just as at a school inspection, where all the torn pinafores are mended, and the pupils faces shining. At all events, until some change for the better is made in the comfort and diversions of the operators at foreign stations, so long will the submarine telegraph service remain a kind of slow-grinding devil's mill for the demoralisation of young men.

THE MICROPHONE AS A RECEIVER.

[Abstract of a paper read before the Royal Society of Edinburgh on 3rd June, 1878, by JAMES BLYTH, M.A., F.R.S.E.]

THE following experiments were suggested by a description of the microphone lately invented by Professor Hughes. Instead of the pointed piece of carbon supported between two pieces of the same material, it occurred to me that gas cinders were likely to answer the purpose tolerably well. To test this I included in the circuit of an ordinary telephone a single Leclanchè cell, and a small jelly jar half filled with gas cinders broken into rather coarse fragments. The connections were made by slipping down, at opposite sides, between the cinders and the sides of the can, two strips of tin to which the circuit wires were attached. When this simple instrument was used as a transmitter, articulate sounds were rendered very loud and distinct in the distant telephone, though occasionally marred by what appeared to be the rattling of the cinders in the can. With this transmitter, sounds were also quite audible even when the speaker stood several yards away from it.

In my next experiment I took a shallow box of thin wood, about 15 in. by 9 in., and filled it with cinders, taking care, in the first place, to nail to the inside of its ends two pieces of tin to which wires could be attached. Having nailed down the thin lid of the box, and included it in the circuit of a telephone, along with a Leclanchè cell, I found that it acted both as a very sensitive microphone, as well as an excellent transmitter for the telephone. With three of these boxes hung up, like pictures, on the walls of an ordinarily-sized room, and connected in circuit, almost every kind of noise made in any part of the room was revealed in the telephone. Speaking was heard distinctly, and a part song by two voices in the middle of the floor was rendered with surprising clearness and accuracy.

In the next experiment, still using the same cell in the circuit, I tried as transmitter a single elongated cinder, with the wires wound tightly round each end. Sounds uttered close to this cinder were quite audible; but I failed to hear them when I substituted for the cinder the carbon of a Bunsen cell, with brass clamps firmly attached to each end, into which the circuit wires were screwed.

I next removed the Leclanchè cell from the circuit, and used as transmitter the jelly jar containing dry cinders. I sometimes fancied that I heard sounds even with the cinders dry, but they become distinctly, though faintly, audible as the cinders become somewhat moistened by the breath of the speaker. On pouring water into the jar, so as almost to cover the cinders, the sounds were heard in the telephone almost as distinctly as when the Leclanchè cell was in circuit. I did not, however, hear any sound with the cinders removed and water only in the jar, not even when the water was made a better conductor by being slightly acidulated.

In the next experiment I tried if the jar with the cinders would act as a receiver, as well as a transmitter, and was not a little surprised to find that it did so. For this purpose I used similar jars of cinder, both for transmitter and receiver, and included a battery of two Groves' cells in the circuit. Articulate sounds uttered in the one cinder jar were distinctly heard in the other, and even voices could be distinguished. Here we have a result which, as far as I know, is quite new, and which renders it quite possible to have an effective telephone worked entirely by the electric current without the aid of magnetism. From some experiments I have recently made, it appears that the loudness of the sounds depends upon the strength of the current in the circuit; and I have no doubt but that excellent telephones can be made in this way, when proper forms, both of transmitter and receiver, are adopted. I have also tried successfully an ordinary telephone as transmitter and a cinder jar as receiver, but in this case the sounds were somewhat fainter and less easily distinguished.

THE PHONOGRAPH AND VOWEL SOUNDS.

AT the same meeting of the Royal Society of Edinburgh, Professor Fleeming Jenkin and Mr. J. A. Ewing made a second communication on the wave forms of articulate sounds, as investigated by help of the phonograph. They had obtained about 200 greatly magnified copies of the tinfoil records, chiefly for the sounds *o* and *oo*, and had

already subjected more than sixty of these to harmonic analysis, extending as far as the sixth partial tone. The results for *o* were consistent with the theory of Donders and Helmholtz, that the vowel quality is given by the reinforcement caused by a constant, or nearly constant, mouth-cavity; this reinforcement extends, however, over a wide range of pitch. The results for *oo* did not seem to be consistent with a constant-cavity theory.

ELECTRIC TELEGRAPHY AT THE UNIVERSAL EXHIBITION OF 1878.

By LE COMTE DU MONCEL.

ELECTRIC telegraphy figures this year in the Paris Universal Exhibition in class 65, and occupies in the French Section an important place in the machinery annex. In the foreign sections electric and telegraphic apparatus, sufficiently rare, by the way, are scattered over various places without any very well defined position, and most frequently in the machinery gallery. We are astonished at the want of order which this year characterises the classification of these important and curious productions.

Without any impartiality, we can say that the French exhibition of telegraphy has this year distinguished itself, and in it are to be found almost all the important models of telegraphs which have been devised in different countries, and which have, moreover, all been tested or employed, more or less, by the French telegraph administration—not only several types of the beautiful multiple telegraphs of Meyer and of Baudot, but also the duplex systems of Stearns, Ailhaud, Mercadier, applied to the Morse and the Hughes; the quadruplex of Le Sieur; the printers of Hughes, D'Arlincourt, Dujardin, Chambrier; the automatic printers of Olsen and Girarbon; Wheatstone's automatic and fast-speed Morses; submarine reflecting telegraphs; the autographic systems of Meyer, Lenoir, D'Arlincourt; the more or less modified forms of Morse, of MM. Cacheteaux, Hequet, Fridblatt, Rault, Chassau, &c., the relays and translators of MM. D'Arlincourt, Tommasi, Meyer, &c., dial telegraphs of diverse forms; lightning-guards, switches, bells and calls of very varied forms and systems.

I have explained in my *Exposé des Applications de l'electricité* the greater part of these systems, and most of them are known to the readers of the *Telegraphic Journal*, from the descriptions of them which have been given in this journal. However, we think we should give some details concerning the multiple telegraph of M. Baudot, which although in its infancy has already given highly important results. It has been possible, in fact, in the six months during which this system has been experimented upon on the Paris-Bordeaux line to transmit as many as two hundred messages per hour, and that without any more employés than are required for the "fast-speed" Wheatstone, which transmits only eighty-five or ninety at most upon this length of line.

The system of M. Baudot belongs to the category of instruments based upon the algebraical combination of simple signals, few in number; and that one may at once recognise its advantages and principle, it is only necessary to consider the time lost in ordinary transmissions by the Hughes' telegraph, and the facility offered by combined simple signals for utilising this lost time.

Let us divide, mentally, into thirty-one intervals, the half second required by the type-wheel of a Hughes printing telegraph to accomplish its revolution. It is clear that if we have the letter A to transmit, we shall only require for its impression a single one of these intervals of time; but for the letter Z we require twenty-eight; so that in the first case we lose no time, while in the latter we lose $\frac{27}{28}$ of the duration of a revolution of the type-wheel. Thus, if by any convenient combination of currents, we could arrange that all the letters of the type-wheel, whatever their alphabetical order, could be printed in the same time, which could then be very brief, we could employ the time served for other transmissions, and at each turn of the type-wheel several letters could be transmitted through the agency of several *employés;* but, as will readily be understood, it would be necessary for this that these combinations of currents should leave, upon a special translating instrument for each *employé*, durable traces of the signal sent, and that these traces should be capable of operating the printing mechanism at the moment that the type-wheel presented to the printing mechanism the letter corresponding to the signal sent. We should also require that a current-distributor should, during each revolution of the type-wheel, transmit the current successively through the different manipulators actuated by the *employés*.

To obtain this complex result, M. Baudot started with the well-known principle, already applied by several physicists, notably by MM. Wheatstone, Morse, Highton, Whitehouse, &c., that with five simple elementary signals, one can obtain by their combinations, one to one, two to two, three to three, &c., thirty-one composite signals which can represent all the letters of the alphabet, and even the figures and other signals most generally employed in telegraphy, adapting to the printing mechanism the transmutator system of Hughes. By this means he was able, therefore, with five successive emissions of current at most, to obtain upon five polarised relays, a durable representation of every letter of the alphabet he wished to transmit; and this transmission required but $\frac{5}{28}$ of the time taken up in one revolution of the type-wheel. These emissions could, moreover, be effected by means of five Morse keys placed under the fingers, and their succession could be mechanically controlled by a distributor travelling synchronously with the type-wheels. And, further, this distributor performing its revolution in one half second, could, as in the multiple system of M. Meyer, be made to present several series of quintuple contacts, each appropriated by a special *employé;* and the number of these series would be limited only by the maximum number of signals capable of being printed during one revolution of the type-wheel. With the ordinary speed of the Hughes, calculation showed that the number of these series might be seven, but M. Baudot makes use of five only, reserving the time which might have been devoted to the other two for the preparation of the signal to be transmitted. With this system, therefore, it is

possible to print ten letters per second, that is, 100 words per minute, or 300 messages per hour; but in reality the speed obtained is somewhat less than this, by reason of the time lost and the multiplicity of contacts, which causes the duration of current necessary for the impression of a signal, to be longer than it theoretically should be.

For the realisation of all the effects above described, the apparatus is composed of six different pieces of mechanism: 1. Five manipulators of five contacts each, distributed over two sides of a large table in the centre of which are placed the printers and other mechanism. 2. A universal distributor and a mechanical corrector for synchronism controlled by a vibrating spring similar to that of M. Hughes. 3. Five relays with quintuple electro-magnets, which represent the translating receivers already alluded to. 4. Five combinators destined to convert the signals transmitted on the translators into local-circuit combinations capable of operating the printing mechanism at the moment when the letters representing these signals are presented before corresponding printers. 5. Five printing receivers connected mechanically with the combinators, which print the message under the influence of the combinations effected by the letter. 6. A mechanical motor, periodically regulated, which drives the receivers and combinators.

In a future article we propose to describe these various parts; but we should here remark, that the system has been recently simplified by M. Baudot; and among the exhibits of M. Dumoulin-Froment, is to be found a specimen of the new model which requires a much smaller number of electrical parts. In the one we have been speaking of there are no fewer than thirty-one electro-magnets; in the latter there is but one, on the other hand the mechanical actions are more complicated and more delicate.

Meyer's multiple telegraph is now well-known, and is employed in different countries. It has everywhere given excellent results, and we are surprised that it has not been more extended. There are two specimens of it in the exhibition, one arranged for six transmissions, which appears in the display made by the French Telegraph Administration, the other arranged for eight transmissions, which is found among the exhibits of M. Hardy, the clever constructor of this apparatus.

(To be continued.)

ELECTRO-DYNAMIC QUALITIES OF METALS.—EFFECTS OF STRESS.

By SIR WILLIAM THOMSON, F.R.S., Professor of Natural Philosophy in the University of Glasgow.

(Abstract.)

THIS paper commences with a detailed description of a series of experiments on the effects of stress on the magnetism of soft iron, of which some first results were described in a preliminary notice, communicated to the Royal Society on the 10th of June, 1875, and published in the "Proceedings." A few months later, the author found that he had been anticipated by Villari* in the most remarkable of those results—that showing increase or diminution of magnetisation by longitudinal pull, according as the magnetising force is less than, or greater than, a certain critical value.

In the first series of experiments described in this paper, the amount of the magnetising force is varied through a range of values from zero to 900, on a scale on which about 12½ is the value of the vertical component of the terrestrial magnetic force at Glasgow, and the effects of hanging on and taking off weights of 7-lbs., 14-lbs., and 21-lbs.,† in changing the induced magnetism, are observed. The experiments were made at ordinary atmospheric temperatures, and at temperature 100° C. The results are shown in curves, of which the abscissæ represent the magnetising forces and other ordinates, the change of magnetism produced by "ons" and "offs" of the weight while the magnetising force is kept constant. The Villari critical value was found to differ for the two temperatures, and for different weights, thus approximately:—

Amount of weight "on" and "off."	Magnetising force for which the "on" and "off" produce no change of magnetism.	
	At atmospheric temperature (being about 15° C.)	At temperature 100° C.
7 lbs.	266	280 or 290
14 ,,	281	286
21 ,,	288	310

The maximum effect of the "on" and "off" was found in each case with magnetising force of from 50 to 60 of the arbitrary scale divisions (or about four times the Glasgow vertical force). Its amount differed notably, though not greatly, with the temperature, and, as was to be expected, greatly with the different amounts of pull; but it was not nearly three times as much with 21 lbs. as with 7 lbs.; thus approximately:—

Amount of weight "on" and "off."	Maximum effect in the way of augmentation of magnetism by "on" and diminution by "off."	
	Temperature about 15° C.	Temperature 100° C.
7 lbs.	31 scale divisions of ballistic galvanometer.	25 scale divisions.
14 ,,	35 do. do.	32·4 do do.
21 ,,	54 do. do.	50·3 do. do.

The curves all tend to asymptotes parallel to the line of abscissæ on its negative side for infinite magnetising forces; and they indicate the following ultimate values for the two temperatures, and the different amounts of pull:—

* Poggendorf's "Annalen," 1868.

† The wire was of about 22 Birmingham gauge, weighing therefore about 14-lbs. per nautical mile. It was so soft that it had experienced a considerable permanent stretch by 21-lbs.; it would probably break with 30 or 40-lbs. Steel pianoforte wire of same gauge bears about 230-lbs.

Amount of weight "on" and "off."	Effect in the way of diminution of magnetism by "on" and augmentation by "off" when the magnetising force is very great.	
	Temperature 15° C.	Temperature 100° C.
7 lbs.	6 scale divisions of ballistic galvanometer.	3 scale divisions.
14 ,,	13·5 do. do.	9·2 do. do.
21 ,,	21 do. do.	15·2 do. do.

For other features the curves themselves as given in the paper may be looked to.

Later experiments on the effects of pull transverse to the direction of magnetisation showed correspondingly *opposite* effects to those of longitudinal pull, but with a "critical value" of magnetising force nearly twice as great. That for longitudinal pull, according to the preceding figures, was about 23 times the Glasgow vertical force; for the transverse pull the critical value found was about 60 times the Glasgow vertical force. The transverse pull was produced by water pressure in the interior of a gun-barrel applied by a piston and lever at one end. Thus a pressure of about 1,000 lbs. per square inch, applied and removed at pleasure, gave effects on the magnetism induced in the vertical gun-barrel by the vertical component of the terrestrial magnetic force, and, again, by an electric current through a coil of insulated copper wire round the gun-barrel, which were witnessed by the audience. When the force magnetising the gun-barrel was anything less than about 60 times the Glasgow vertical force, the magnetisation was found to be less with the pressure on than off. When the magnetising force exceeded that critical value, the magnetisation was *greater* with the pressure on than off. The residual (retained) magnetism was always less with the pressure on than off (after ten or a dozen "ons" and "offs" of the pressure to shake out as much of the magnetisation as was so loosely held as to be shaken out by this agitation).

The vertical component of the terrestrial magnetic force at Glasgow is about ·43 c.-g.-s. units. Hence the critical values of the magnetising force for longitudinal and transverse pull are approximately 10 and 25 c.-g.-s. units. With any magnetising force between these limits the effect of pull whether transverse or longitudinal must be to diminish the magnetisation. Hence it is to be inferred that equal pull in all directions would diminish, and equal positive pressure in all directions would increase, the magnetisation under the influence of force between these critical values, and through some range above and below them; and not improbably for all amounts, however large or small, of magnetisingforce; but further experiment is necessary to answer this question.

The opposite effects of longitudinal and transverse pull, for magnetising forces not between the critical range of from 10 to 25 c.-g.-s. units, show an aeolotropic magnetic susceptibility in iron under aeolotropic stress [that is, any stress or other than pressure (whether positive or negative) equal in all directions]. Consideration of the relation of this result to Wiedemann's remarkable discovery of the induction of longitudinal magnetisation by twisting an iron wire through which an electric current is maintained, is important and suggestive. In the present paper counter-influence is pointed out, in the aeolotropic change of electric conductivity probably produced in the iron by the stress. This influence illustrated by experiments made a few days ago by the author, by Mr. Macfarlane, in Glasgow, and Mr. Bottomley, in the Physical Laboratory of King's College, London, by kind permission of Professor Adams, which shows in two very different ways that twisting a brass tube through which a current of electricity is maintained gives to the electric stream lines a spirality of opposite name to that which the twist gives longitudinal filaments of the substance, and so proves that in aeolotropically stressed brass the electric conductivity is greatest and least in the directions of greatest and least pressure. The same law probably holds for iron. Wiedemann's result is that the end of the iron wire by which the current enters, becomes a true north or a true south pole, according as the twist is that of a right handed or of a left handed screw. This is the same direction of effect as would result from the aeolotropy of the magnetic susceptibility produced by the stress of the tangential magnetising force in the outer part of the wire is less than the critical value, for which the effect of the stress is isotropic; but it is opposite to the effect due to the aeolotropy of the electric conductivity. Yet the same author in repeating Wiedemann's experiments has found his result—the same in direction, and greatest in amount—with the strongest currents he has hitherto applied—currents strong enough to heat the wire seriously (but not yet measured or estimated in absolute measure). The reconciliation of the Wiedemann result with the conflicting influence of conductive aeolotropy, and with the influence of aeolotropy of magnetic susceptibility, which also is conflicting when the magnetizing force is great enough, is a difficulty which calls for investigation.

The paper includes a series of experiments on the effects of twist on magnetisation of iron wire under longitudinal magnetising force (the Glasgow vertical force alone in this first series). Results of previous experimenters, Matteucci, Wertheim, and Edward Becquerel, according to which twist in either direction diminishes the magnetisation, and extends them to wires under different amounts of longitudinal pull. When the pull was great, approaching the limit of elasticity of the wire, the twist, even when well within the limits of elasticity, had much less effect in diminishing the magnetism than when the pull was small. The results are recorded in curves which show a very remarkable lagging of effect, or residue of influence depending on previous conditions.

The paper concludes with a description of experiments, showing in bars of nickel and cobalt effects of longitudinal pull opposite to those found by Villari for iron with magnetising force below the critical value—that is to say, the magnetisation of the nickel and cobalt was diminished by pull. But this effect came to a maximum, and began to diminish markedly as if towards zero, when the magnetising force was diminished. Hitherto the critical value, if there is one, has not been reached; but the experiments are being continued to find a reversal of the effect, if it is to be found, with attainable degrees of magnetising force.—*Proceedings of the Royal Society.*

THE PHONOGRAPH AND ITS FUTURE.

By T. A. EDISON. *

OF all the writers' inventions, none has commanded such profound and earnest attention throughout the civilized world as has the phonograph. This fact he attributes largely to that peculiarity of the invention which brings its possibilities within range of the speculative imaginations of all thinking people, as well as to the almost universal applicability of the foundation principle, namely, the gathering up and retaining of sounds hitherto fugitive, and their reproduction at will.

From the very abundance of conjectural and prophetic opinions which have been disseminated by the press, the public is liable to become confused, and less accurately informed as to the immediate result and effects of the phonograph than if the invention had been one confined to certain specific application, and, therefore, of less interest to the masses. The writer has no fault to find with this condition of the discussion of the merits and possibilities of his invention: for, indeed, the possibilities are so illimitable, and the probabilities so numerous, that he—though subject to the influence of familiar contact—is himself in a somewhat chaotic condition of mind as to where to draw the dividing line. In point of fact, such line cannot with safety be defined in ordinary inventions at so early a stage of their development. In the case of an instrument of the nature and scope of the phonograph, it is practically impossible to indicate it to-day, for to-morrow a trifle may extend it almost indefinitely.

There are, however, certain stages in the developing process which have thus far been actually reached; certain others which are clearly within reach; and others which, though they are in the light of to-day to be classed as possibilities, may to-morrow become probable, and a little later actual achievements. It is the intention of the writer in this article to confine himself to the actual and the probable, to the end that a clearer conception of the immediate realization of the phonograph may be had. He concedes to the public press and the world of science the imaginative work of pointing and commenting upon the possible. It is in view of the liberal manner in which this has already been done, and the handsome treatment he has received at their hands, that he for the first time appears *in propriâ personâ* to discuss and comment upon the merits of one of his own inventions.

In order to furnish a basis upon which the reader may take his stand, and accept or combat the logic of the writer in his presentment of the probabilities of the phonograph, a few categorical questions are put, and answers given upon the essential features of the principle involved:

1. Is a vibrating plate or disc capable of receiving a complex motion which shall correctly represent the peculiar property of each and all the multifarious vocal and other sound-waves?

The telephone answers affirmatively.

2. Can such complex movement be transmitted from such plate by means of a single embossing point attached thereto, to effect a record upon a plastic material by indentation, with such fidelity as to give such indentations the same varied and complex forms; and, if so, will this embossing point, upon being passed over the record thus made, follow it with such fidelity as to retransmit to the disc the same variety of movement, and thus effect a restoration or reproduction of the vocal or other sound-waves, without loss of any property, essential to producing upon the ear the same sensation as if coming direct from the original source?

The answer to this may be summed up in a statement of the fact that by the application of power for uniformity of movement, and by attention to many seemingly unimportant and minor details, such as the *form* and material of the embossing point, the proper *damping* of the plate, the character of the material embossed, the formation of the mouthpiece over the plate, &c., the writer has at various times during the past week reproduced the waves with such degree of accuracy in each and every detail as to enable his assistants to read, without the loss of a word, one or more columns of a newspaper article unfamiliar to them, and which were spoken into the apparatus when they were not present. The only perceptible loss was found to be in the quality of the utterance—a non-essential in the practical application of the apparatus. Indeed, the articulation of some individuals has been very perceptibly improved by passage through the phonograph, the original utterance being mutilated by imperfection of lip and mouth formation, and these mutilations eliminated or corrected by the mechanism of the phonograph.

3. Can a record be removed from the apparatus upon which it was made, and replaced upon a second without mutilation or loss of effective power to vibrate the second plate?

This is a mere mechanical detail, presenting no greater obstacle than having proper regard for the perfect interchangeableness of the various working parts of the apparatus—not so nice a problem as the manufacture of an American watch.

4. What as to facility of placing and removing the record-sheet, and as to its transportation by mail?

But ten or fifteen seconds suffice for placing or removal. A special envelope will probably be required for the present, the weight and form of which, however, will but slightly increase the cost of postage.

5. What as to durability?

Repeated experiments have proved that the indentations possess wonderful enduring power, even when the reproduction has been effected by the comparatively rigid plate used for their production. It is proposed, however, to use a more flexible plate for reproducing, which, with a perfectly smooth stone point, diamond or sapphire, will render the record capable of from 50 to 100 repetitions, enough for all practical purposes.

6. What as to duplication of a record and its permanence?

Many experiments have been made, with more or less success, in the effort to obtain electrotypes of a record. This work has been done by others, and, though the writer has not as yet seen it, he is reliably informed that, very recently, it has been successfully accomplished. He can certainly see no great practical obstacle in the way. This, of course, permits

* From *The North American Review*, May-June, 1878.

of an indefinite multiplication of a record, and its preservation for all time.

7. What are the requisite, force of wave impinging upon the diaphragm, and proximity of the mouth to the diaphragm to effect a record?

These depend in a great measure upon the volume of sound desired in the reproduction. If the reproduction is to be made audible to an audience, considerable force is requisite in the original utterance; if for the individual ear, only the ordinary conversational tone (even a whisper has been reproduced). In both cases the original utterances are delivered directly in the mouth-piece of the instrument. An audible reproduction may, however, be had by speaking at the instrument from a distance of from two to three feet in a loud tone. The application of a conical tube or funnel to collect the sound waves, and the construction of an especially delicate diaphragm and embossing point, &c., are the simple means which suggest themselves to effect this. The writer has not as yet given this stage of the development much attention, but sees no practical difficulty in gathering up and retaining a sectional part of the sound waves diffused about the original source within a radius of, say, three feet (sufficiently removed not to be annoying to a speaker or singer).

(To be continued.)

PROFESSOR CLERK-MAXWELL ON THE TELEPHONE.

ON Friday, May 24th, a large audience filled the Senate House to hear the Rede Lecture, the lecturer being Professor Clerk-Maxwell, and the subject "The Telephone." The Vice-Chancellor presided, and introduced the lecturer, who delivered his discourse to the following effect:—

The telephone is so simple in construction that I have not yet met anyone acquainted with the first elements of electricity who has experienced the slightest difficulty in understanding the physical process involved in its action.

It would be as useless as it would be tedious to try to explain the various parts of this small instrument to persons in every part of the Senate House. I shall, therefore, consider the telephone as a material symbol of the widely separated departments of human knowledge, the cultivation of which has led, by as many converging paths, to the invention of this instrument by Professor Graham Bell.

For whatever may be said about the importance of aiming at depth rather than width in our studies, and however strong the demand of the present age may be for specialists, there will always be work, not only for those who build up particular sciences and write monographs on them, but for those who open up such communications between the different groups of builders as will facilitate a healthy interaction between them.

We shall begin with the telephone in its most obvious aspect, as an instrument depending on certain physical principles.

The apparatus consists of two instruments, the transmitter and the receiver, doubly connected by a circuit capable of conducting electricity. The speaker talks to the transmitter at one end of the line, and at the other end of the line the listener puts his ear to the receiver, and hears what the speaker says.

The process in its two extreme stages is so exactly similar to the old-fashioned method of speaking and hearing with the speaking tube, that no preparatory practice is required on the part of either operator.

In the electric telephone there is a medium extending from the one instrument to the other. It is a copper wire, or rather two wires forming a closed circuit. But it is not by any motion of the copper that the message is transmitted. The copper remains at rest, but a variable electric current flows to and fro in the circuit.

It is this which distinguishes the electric telephone from the ordinary speaking tube, and from the transmission of vibrations along wooden rods by which Sir Charles Wheatstone used to cause musical instruments to sound in a mysterious manner without any visible performer.

We have to distinguish the principle of the articulating telephone from that of a great number of electrical contrivances which produce visible or audible signals at a distance. Most of these depend on the alternate transmission and interruption of an electric current. In some part of the circuit a piece of apparatus is introduced corresponding to this instrument, which is called a key. Whenever two pieces of metal, called the contact pieces, touch each other, the current flows from the one to the other, and so round the circuit. Whenever the contact pieces are separated the current is interrupted, and the effects of this alternation of current and no current may be made to produce signals at any other part of the circuit.

In the Morse system of signalling, the rate at which currents succeed one another depends on the rate at which the operator can work the key; if this rapidity of succession is by any means very much increased, the ear ceases to distinguish separate signals, but begins to recognise the impression it receives as that of a musical tone, the pitch of which depends on the number of currents in a second.

Tuning forks, driven by electricity, were used by Helmholtz in his researches on the vowel sounds, and whenever we have occasion to follow the march of a process which takes place in a short time, such as the vibration of a violin string, the tuning fork becomes our appropriate timepiece.

Apparatus of this kind, however, the merit of which is its regularity, is quite incapable of adapting itself to the transmission of variable tones such as those of a melody.

The first successful attempt to transmit variable tones by electricity was made by Philip Reis. On October 21, 1861, Reis showed his instrument, which he called a telephone, to the Physical Society of Frankfort-on-the-Main. He succeeded in transmitting melodies which were distinctly heard throughout the room.

If the pitch of a sound were the only quality which we are able to distinguish, the problem of telephony would have received its complete solution in the instrument of Reis. But the human ear is so constructed, and we ourselves are so trained by continual practice, that we recognise distinctions in sound of a far more subtle character than that of pitch; and these finer distinctions have become so much more important for the purposes of human

intercourse than the musical distinction of pitch, that many persons can detect the slightest variation in the pronunciation of a word who are comparatively indifferent to the variations of a melody.

Now, the telephone of Professor Graham Bell is an articulating telephone, which can transmit not only melodies sung to it, but ordinary speech, and that so faithfully that we can often recognise the speaker by his voice as heard through the telephone. How is this effected? If the electrical part of the process consisted merely of alternations between current and no current, the receiving instrument could never elicit from it the semblance of articulate speech.

What we want is not a sudden starting and stopping of the current, but a continuous rise and fall of the current, corresponding in every gradation and inflexion to the motion of the air, agitated by the voice of the speaker.

The electric principle involved in Bell's telephone is that of the induction of electric currents discovered by Faraday in 1831.

Consider first a conducting circuit, that is to say, a wire which after any number of convolutions returns into itself. Round such a circuit an electric current may flow, and will flow if there is an electromotive force to drive it.

Consider next a line of magnetic force. This line, as Faraday first showed, is a line returning into itself, or, as the mathematicians would say, it is a closed curve.

Now, if there are two closed curves in space, they must either embrace one another so as to be linked together, or they must not embrace each other.

If the line of force as well as the circuit were made of wire, and if it embraced the copper circuit, it would be impossible to unlink them without cutting one or other of the wires.

Now, if the copper circuit, or the lines of force, move relatively to each other, then, in general, some of the lines of force, which originally embraced the circuit, will cease to embrace it, or else some of those which did not embrace it will become linked with it.

For every line of force which ceases to embrace the circuit there is a certain amount of positive electro-motive force, which, if unopposed, will generate a current in the positive direction, and for every new line which embraces the circuit there is a negative electro-motive force, causing a negative current.

In Bell's telephone the circuit forms a coil round a small core of soft iron fastened to the end of a steel magnet. Now, lines of magnetic force pass more freely through iron than through any other substance. They will go out of their way in order to pass through iron instead of air. Hence a large proportion of the lines of force belonging to the magnet pass through the iron core and, therefore, through the coil, even though there is no iron beyond the core, so that they have to complete their circuit through air.

But if another piece of soft iron is placed near the end of the core, it will afford greater facilities for lines which have passed through the core to complete their circuit; and so the lines belonging to the magnet will crowd still closer together, to take advantage of an easy passage through the core and the iron beyond it. If, then, the iron is moved nearer to the core, there will be an increase in the number of such lines, and, therefore, a negative current in the circuit. If it is moved away there will be a diminution in the number of lines, and a positive current in the circuit. This principle was employed by Page in the construction of one of the earliest magneto-electric machines, but it was reserved for Professor Bell to discover that the vibrations of a tinned iron plate, set in motion by the voice, would produce such currents in the circuit as to set in motion a similar tin plate at the other end of the line.

(To be continued.)

Review.

Exposé des Applications de l'électricité. Par LE COMTE DU MONCEL, &c., &c. Tome V. Applications Industrielles. Paris: Eugène Lacroix, 54, Rue des Saints-Peres.

IN the work before us the indefatigable Comte du Moncel brings his arduous undertaking to a close. The five volumes with which he has enriched scientific literature have dealt in the most thorough and masterly style with the manifold practical applications of electricity. This fifth volume bears more especially upon such practical applications as are of use in manufactures, and is brought down to the most recent times, so that an account of Bell's articulating telephone, and other forms of telephones, and also of Jablochkoff's recent invention of the kaolin candle for electric lighting are included.

Some idea of the comprehensive nature of the contents of the present volume may be gathered from the following summary:—The applications of electricity for increasing the safety of railways by means of telegraphic indicators, the block system, and the application of electricity for lighting purposes, with a very full account of all that has been as yet theoretically or actually accomplished in this direction; the uses of electricity in civil and military mining, the explosion of torpedoes, its employment as a means of protection against the destructive effects of thunder-storms, its use in electric toys, electro-motive engines, &c., &c. The chief section of the work, however, is devoted to the mechanical application of electricity to various industries, arts, and domestic economy, such as in weaving, musical instruments, fire and other alarm signals, and so forth.

To have carried to a successful issue so vast an undertaking as this would tax the entire energies of an ordinary man. But the author seems to possess an unwearied power of work, for he tells us that in addition he has made thousands of experiments, verified all his electro-magnetic formulæ by actual trial, and published the results of his researches in at least half a dozen lengthy memoirs. M. du Moncel, we suspect, must have some secret application of electricity to the production of brain work, and we implore him to confide to us this great secret.

One fault some may find, but it is an almost unavoidable one when one man undertakes so herculean a labour, namely, that the inventions of the author's countrymen occupy perhaps too con-

spicuous a portion of the work. Our own columns are laid under frequent contribution by the Comte, to whom we would take this opportunity of expressing our thanks for the handsome manner in which he invariably acknowledges the sources of his information and his generous appreciation of the *Telegraphic Journal*. Excellent plates and numerous woodcuts illustrate the preceding volumes as well as this Part V., which extends to 353 pages, and is nevertheless sold at 12 fr. 50 c. When will English booksellers learn the lesson the French are so continually teaching us, of giving us the book and leave the binding to take care of itself as taste or means may dictate.

Heartily do we congratulate the distinguished author on the completion of his laborious task, which he tells us "Has cost more labour than anticipated, as the help on which we depended completely failed us. We believe," the Comte adds, "that we have carried our work to the limit of present scientific progress, and if some recent telegraphic inventions have rendered the third volume, which deals exclusively with this subject, somewhat incomplete, we hope to remedy this defect in a work to be published at some future day."

It goes, without saying, that the study of these five volumes will give any reader a complete idea of the numerous practical applications of electrical science. Their scope is, however, wider than this, as we have pointed out in previous notices of the earlier parts, for the sources of electricity are fully dealt with, and when needful, theoretical as well as practical points are amply discussed. The scientific public owe Comte du Moncel a large debt of gratitude for the compilation of these volumes, which will always be a mine of information to the engineer and a monument of industry in memory of the author.

W. F. B.

Notes.

THE TELEPHONE.—The first telephonic accident is reported from Hartford, Connecticut, United States. A medical man of that town was recently conversing by telephone with his assistant at the drug store, when a thunderclap burst over head. The doctor observed the telephone in his hands blaze with light at the moment of the lightning flash, and found the coil inside to be fused. The assistant who at the moment held his telephone to his ear in the act of listening, was struck deaf by a loud report like the explosion of a pistol, and continued deaf for several hours.

M. GRENIER, at the French Academy recently, pointed out that besides the induction clamour on air telephone lines, there are irregular noises often very loud, which are best heard in the stillness of night, and he attributes them to terrestrial currents in the wires. M. Du Moncel attributed these currents to the differences of temperature in the wires caused by solar heating, as the sunlight travels over the earth's surface.

RECENT experiments by M. Navez, a French lieutenant of artillery, appear to negative the deduction of Count du Moncel, that it is the core of a Bell telephone which gives out the sounds. Five telephones were tried by him without discs, and although the sending telephone was one of Edison's, giving loud articulation when the discs were present, they were entirely mute without the latter. M. Navez concludes that the core does not produce sonorous vibrations by itself; but undergoes magnetic variations which cause the plate or disc to vibrate so as to give out sound. This brings us back to the original explanation of the action of the telephone, and it is probable that the curious results of Mr. Spottiswoode and others may have been due to conditions in which mere molecular vibration played an important part. M. Navez also obtained speech by means of plates of copper, glass, wood, cardboard, vulcanised india-rubber, gutta-percha, and paper, the non-metallic substances being coated with copper foil. The intensity of the sound varied with the material of the plate, but the pitch and quality were sensibly the same for all.

IN order to eliminate the metallic twang of certain telephones, M. Maiche forms the plate of a sheet of caoutchouc 4 centimetres in diameter and 1 millimetre thick, stretched in front of the pole of the magnet. At the centre of this sheet and opposite the pole in question, he fixes a disc of white iron 1 millimetre thick and 3 centimetres in diameter. M. Maiche has also remarked that the plate of the sending telephone may be 8 or 10 centimetres in diameter; but that of the receiver gives a maximum effect when between 30 and 40 millimetres in diameter.

PROFESSOR SAMUEL E. RUSK (America) has observed that ordinary telegraph instruments give out the tunes and sometimes the words spoken into the line through a telephone.

PROFESSOR RUSK has also devised a telephone call within the instrument itself. By pressing a knob, the sound of the voice is given out at the receiving telephone sufficiently loud to draw attention. On relieving the knob, speaking can be carried on in the usual way. We suppose the knob throws a battery in circuit and the vibrations of the diaphragm then interrupt the circuit; a plan which we believe M. Breguet is also working out.

THE MICROPHONE—ITS INVENTOR.—The Duke of Argyle in speaking at the special meeting of the Society of Telegraph Engineers on the occasion of the reading of Professor Hughes' paper on the Microphone, said that he was glad that that invention had been made by one who, although long a resident in this country, was by birth a citizen of the United States. The Duke then went on to say that although no one was more patriotic than he, yet he was thoroughly cosmopolitan

in matters of science, and, moreover, he could never forget the fact that the Americans were our own fellow countrymen. Most Englishmen will cordially agree with the last remark; for although some Americans will stubbornly entertain the idea that Englishmen are prejudiced against them through jealousy, it is a mistake on their part. They are somewhat thin-skinned as a race, and attach too much importance to the half-jesting criticism of Englishmen. We are proud of the recent great inventions of America, and give her full credit for them. It would have been well, however, had the Duke of Argyle verified his information on the subject of Professor Hughes' birth before alluding to it in such terms. Professor Hughes is not an American. His parents were Welsh, and he himself was born in London. He went to America with his parents when very young; and may be said to have received his education in America. He early developed a strong liking and fitness for the physical sciences, and was appointed Professor of Physics, in Columbia College, Louisville, Kentucky, at the age of 19. His first great work the Hughes' Type-Printer, was done in America, and should be regarded as an American invention. The Microphone, however, is, on the other hand, a peculiarly English invention. Professor Hughes has for many years resided in London, the city of his birth, and it was last winter while confined to his chamber by an attack of bronchitis, the result of our sterling English climate, that to amuse himself he directed his mind to the telephone, and to the problem of discovering a means of making the wire or some part of the circuit itself speak. The experiments of Sir William Thomson on the modification of the resistance of wires under stress gave him the clue which he has followed up with such remarkable success. It is curious to learn that the term Microphone was apparently first used and applied by Mr. H. G. Bonavia Hunt (Mus. B., Oxon) at a lecture which he gave to the students of Trinity College, London, about nine months ago, on some simple means of magnifying normally inaudible sounds, and so obtaining the natural harmonies of bells, steel bars, and other instruments, musical or otherwise. In fact, twelve months ago, Mr. Hunt employed a rough and ready microphone, for experiments; but not, we understand, of a kind similar to that of Professor Hughes.

THE sale of microphones has been promptly opened by our enterprising instrument makers. Messrs. Lancaster and Sons, Birmingham, offer a very handy kind in which the battery is formed of a zinc and carbon plate, with moistened paper between, the carbon plate being at the same time the base plate of the microphone, which consists of an upright pencil of carbon standing on the base plate and leaning against another horizontal plate of the same material. The resistance of this pile is very small. Mr E. Paterson, Covent Garden, Mr. J. W. E. Archbutt, Westminster Bridge, Messrs. Tisley and Co., Brompton Road, Messrs. Ladd & Co., Beak Street, Regent Street, Mr. Volk, of Brighton, and Messrs. Jackson & Co., Barbican, are all advertising different varieties of microphone.

AT the recent *soirée* of the Institution of Civil Engineers, the famous fly-walking experiment with the microphone was a source of great interest to the guests; and we observed not a few worthy civil engineers to be greatly excited over the peregrinations of a fly which had been stone dead for a considerable time. The poor fly had got crushed under its prison walls—a martyr to science—but the *savants* of the *soirée* heard it walking all the same. It should be added that there was a good deal of talking and moving about in the rooms.

PROFESSOR HUGHES states that the best articulation is obtained from the microphone when the internal resistance of the latter is half the external resistance of the circuit.

MR. F. J. M. PAGE, of the Physiological Laboratory, University College, writes to a contemporary to point out that speaking or singing into a microphone caused large and definite movements of the mercury column of a Lippmann's electrometer connected in circuit with it, but placed 25 feet from the microphone. The microphone circuit was formed of three pieces of gas carbon, a Daniell cell and the primary coil of a Du Bois-Raymond induction coil. The secondary coil was in circuit with the electrometer.

WITH a single bichromate cell the microphone can be employed on a circuit of 10,000 ohms resistance; and with an induction bobbin it may be heard through much higher resistances.

ALL letters are sent by microphone with equal facility except S, which, when final, is lost, but may be divined from the rest of the sentence.

BY the introduction of an induction bobbin in the microphone circuit, the Bell telephone is made to speak so loud as to be heard throughout a large hall.

DR. RICHARDSON is engaged in applying the microphone as a means of auscultating the lungs and heart.

THE microphone is an extremely sensitive thermoscope. The heat of the hand on approaching it, and the sunshine and shadow, cause considerable variations in the current passing through it. In fact, so sensitive is it to heat that it is almost impossible to keep it in the same state.

WITH the aid of Professor Hughes, Sir Henry Thompson has successfully applied the microphone to the operation of lithotrity, or crushing of stone n the bladder. As practised at present, the delicacy of the

surgeon's sense of touch is the only detector of the pieces of stone; but with a microphone attached to the handle of the Sound, or crushing instrument inserted into the bladder, it is possible to detect minute fragments of stone which formerly escaped notice, and consequently to crush them, and render the operation more thorough and complete. On Tuesday, June 4, Sir Henry demonstrated this use of the microphone in the Anatomical Theatre of University College, before a crowded audience of his profession. The microphone must not be too sensitive, and the contact of the Sound with the bladder walls should give a soft noise quite distinct from the sharp metallic ring when it strikes a piece of stone.

THE microphone, when fitted to probes, will doubtless become useful to detect bullets or fragments of bone in wounds. Practice will be necessary to enable the surgeon to tell the nature of the foreign matter, whether it be bone or bullet.

AT the meeting of the Physical Society on Saturday, June 8, Professor Hughes gave an account of the microphone, and added some interesting facts to those already published by him. He finds that a continuous sound may be given out by the telephone in circuit with a microphone by a mutual interaction of the two instruments. For example, let the telephone be placed on a table, then if the microphone in circuit with it be set down on the table also, the jar of placing it will cause the microphone to elicit a sound from the telephone; this sound in the telephone will in its turn again jar the microphone, a second sound will be produced in the telephone, and so on—the sound relaying itself. In this way the microphone can be used to relay or translate the voice over wires. Professor Hughes also broke up the continuous humming into dots and dashes.

BY means of the microphone circuit placed against the head, Professor Hughes has enabled deaf people to hear the tick of a watch and other small sounds; and he has been led to the curious supposition that it is through the bones of the head, and not through our ears, that we hear ourselves speak. In connection with this subject, we may mention that deaf persons, or those stopping up their ears, can be made to hear the speaking of a string telephone by passing the string in a loop round their temples. At the same meeting attention was also called to Edison's Carbon Telephone, which evidently depends for its action, at least to a certain extent, on the principle of the microphone. But it cannot be claimed for Mr. Edison that he in any way anticipated the microphone. He discovered the property which carbon possesses of diminishing its resistance under pressure, and applied it to the telephone. Professor Hughes, by a line of reasoning and experiment not even suggested by Edison's telephone, has arrived at the general principle that the resistance of a large class of bodies is modified by sonorous and other mechanical vibrations. Carbon happens to be a particular case of this generalisation. Professor Hughes employs it in the microphone because it is a good and inexpensive conductor. Mr. Edison, had he gone further, might have discovered the microphone. As it is, his carbon telephone is not a microphone. Professor Hughes showed that so long as the diaphragm was there it could not become one. The ticking of a delicate watch, and other small sounds, cannot be heard in an Edison telephone; take the diaphragm away and they can, for it then becomes a particular form of microphone.

A GENTLEMAN in Halifax, L. J. Crossley, Esq., who takes great interest in electrical matters, had a microphone placed in a chapel on Sunday, June 3rd, and connected with his residence, about a mile away, by means of a telegraph line passing near the chapel. The whole of the service was heard, with the exception of a few words, which were occasionally lost through the preacher shaking the microphone, about the presence of which he knew nothing. During the week, a microphone has been placed in the schoolroom of another chapel, and the singing of the scholars was carried in a number of directions by means of telegraph wires. We understand that the microphone is about to be put to practical use for the conveyance of sermons, &c., the gentleman already named having made arrangements for his house being connected with that of a gentleman near, in order that an invalid lady may have the pleasure of hearing in her own room the service of a church over a mile distant.

MR. CROSSLEY and MR. EMMOTT, of Blakey Bros. and Emmott, have also succeeded in speaking, and in transmitting the trampling of a fly, &c., by microphone, over two telegraph wires, between Bradford and Dean Clough, looped at Bradford, so as to make twenty miles of wire in all.

THE PHONOGRAPH.—The phonograph is being exhibited daily in action at the various establishments of the London Stereoscopic Company, who are sole licensees of Mr. Edison's patent. As the nature of the point of the stylus is found to be important in affecting the articulation, these points are now made of ruby. Any improvements Mr. Edison makes on this, his favourite invention, will be reproduced by Mr. Stroh, the maker in England. The Stereoscopic Company have also issued an interesting shilling pamphlet on the phonograph, including extracts from Mr. W. H. Preece's lecture before the Physical Society, and the reports and interviews of several American journalists with Mr. Edison.

AT the opening of the new Metropolitan Central Fire Brigade Station at Southwark Bridge Road, it was stated that, in 1866, there were only 15½ miles of telegraph line in use by the Fire Brigade in the Metro-

polis, whereas there are now 104 miles. There is now instantaneous telegraphic communication between all the stations, and the arrangements for the protection of property within the City proper, were much more complete and efficient than they ever could be before. We may add that there are now 50 Fire Engine Stations, 4 Floating Stations, 3 Floating Steam Fire Engines, 27 Land Steam Fire Engines, 98 Manual Engines, and 406 men of all ranks. It is to be hoped that the next improvement will be the systematic introduction of Fire Telegraphs.

AT the recent special meeting of the Society of Telegraph Engineers, Dr. C. W. Siemens, in pointing out the probable utility of the telephone, microphone, and phonograph, threw out the suggestion that the gray matter of the brain may be a kind of phonograph foil on which are recorded all the impressions of our senses, and which serves as a store-house of experience. The idea is interesting inasmuch as it gives us a glimpse of an old fact from a new point of view.

IN the new fairy drama of "Elfinella," at the Princess's Theatre, the electric light is employed with very beautiful effect.

TELEGRAPHIC COMMUNICATION WITH THE CAPE OF GOOD HOPE.—In reply to Colonel Mure, Sir M. H. Beach, in the House of Commons, on May 31st, stated that recent events had specially directed the attention of Her Majesty's Government to the want of telegraphic communication between this country and the Cape of Good Hope. Looking to the peculiar circumstances of the case, and the absence of any prospect that within a reasonable time such communication would be established by private enterprise, they would be prepared to give favourable consideration to a proposal that in some form or other the Government should aid in such an undertaking, provided that the several colonies interested also contributed to the work. Shortly after his accession to office, he addressed a despatch to this effect to the governors of the several colonies; and should the replies be favourable, he would lose no time in inviting the attention of his colleagues to the details of the subject, in order that the best plan might be adopted for carrying out a proposal which was of the greatest importance.

A brilliant bluish fire-ball passed over south-west London about 9.30 p.m., June 7th, proceeding in a north westerly direction.

THE Great Northern Company's Hong-Kong-Amoy Cable has been provisionally repaired. Further repairs have been postponed until the Singapore route has been re-established. The repairing operations were commenced on May 27th.

AT a recent meeting of the London Clinical Society, Mr. McHardy gave an interesting account of the extraction of an iron chip from the eye of a smith, by means of a magnet. The chip had entered the crystalline lens within the pupil. An electro-magnet, actuated by two Groves's cells, was directed to the cornea, and when four inches distant, the chip sprang from the lens to the inner surface of the cornea, and fell into the anterior chamber, whence it was removed.

THE Eastern Extension Company notify the repair of their Singapore-Saigon Cable. Messages can now, therefore, be forwarded to China and Japan by that route.

THE short section of the Direct United States Cable between Torbay N.S., and Ryebeach, N.H., has been repaired.

THE Government of Buenos Ayres intend to establish a telegraph line from Zarate to Entre Rios, so that messages may go direct instead of by Rosario.

MR. J. A. EWING, B.Sc., F.R.S.E., has been appointed Professor of Mechanical Engineering in the University of Tokio, Japan.

THE Messenger Call system will be commenced in London on and after July 1st, by "The Exchange Telegraph Company," of 17 and 18, Cornhill, that company having already secured a sufficient number of subscribers to warrant every probability of success.

THE freaks of lightning are many and versatile; but we confess we were not quite prepared to hear the announcement made the other day by a reporter of the most learned *Times* that, during a recent thunderstorm at High Ongar, the lightning "ignited a quantity of unslaked lime."

DURING the thunderstorm which passed over Perthshire on June 4th, the obelisk erected near Crieff, in 1832, in memory of Sir David Baird, the hero of the storming of Seringpatum, was almost entirely destroyed by lightning. It was 80 feet in height, and cost £4,000 to erect.

THE Lord Chancellor, in moving the second reading of the Telegraphs Bill in the House of Lords, stated that it was the object of the bill to provide one general Act for the protection of the telegraphic system. It was the wish of various telegraphic companies that a special Act should be passed for that purpose.

TELEGRAPHISTS' PARALYSIS.—As a remedy for this complaint, so prevalent in America, Mr. Barron, a practical operator, has, we learn from the *Journal of the Telegraph*, invented a flexible or elastic knob for the signalling key, which relieves the strain on the hand and fingers caused by grasping a rigid knob in signalling. It is now used by all the operators on the Associated Press wire, and those on the fast Western

Union circuits worked from New York. Operators who have suffered from paralysis are said to find relief in their use.

IT is proposed to erect a monument to the memory of the late Mr. William Orton, president of the Western Union Telegraph Company, U.S.

AS a slight specimen of American "hifalutin" oratory—for the abundance of which we cannot help thinking that Mr. Emmerson is greatly to blame—we extract the following from a lecture by the Rev. T. Dewitt Talmage on the late Mr. Orton:—"From the most animated electric life he has gone to lie down in the village cemetery. . . He was the martyr of American telegraphy. . . He had been gathering up the lightnings of the Pacific and Atlantic, the Gold and Stock, Southern and Atlantic, the Atlantic and Pacific Telegraph Companies, and a cable company to Cuba; and no wonder that in the attempt to harness and drive so many lightnings the hands that grasped the fiery reins were consumed." "Gathering up the lightnings" is surely a very poetical rendering of the establishment of a telegraph monopoly.

ACTION OF LIGHT ON SELENIUM.—Recent experiments of Mr. R. Sabine on this subject (see the *Phil. Mag.* for June) tend to prove that the impingeing light effects a true decrease in the resistance of the selenium, rather than rise of electro-motive force in the same direction as that of the battery.

WE hear that Muirhead's duplex system is about to be applied to the Madras-Penang section of the Eastern Extension Telegraph Company's system.

MR. FULLER, an American, has patented in the United States an electric wick, formed of two carbon sticks placed side by side, at an angle to the vertical, but separated from each other by a slip of glass, which fuses in the current as it passes between the points of the carbons, after the manner of the kaolin in Jablochkoff's electric candle. This lamp is said to cost only 12s., but it is a variety of the electric candle. Jablochkoff does not restrict himself to kaolin, but mentions other refractory substances, and the principle is his discovery. Mr. Fuller is also the inventor of a dynamo-electric machine, and a method of dividing the current so as to supply lamps of different sizes.

DURING one of her recent cruises the French war-ship *Desaix* had in tow an old vessel called the *Argonaute*, which served as a torpedo boat, and telephonic communication was maintained between the two ships during the whole time. An insulated conductor was wound round the tow-rope, and the return circuit was formed by the sea, a circumstance which in the opinion of M. Trève, one of the officers of the *Desaix*, improved the definition of the sounds.

ALLOTROPY OF ELECTRIC RESISTANCE.—At the meeting of the Physical Society on May 25, Sir William Thomson stated that the spiral flow of an electric current traversing a metal tube under torsion may be resolved into two components—one right along the tube, the other round it. The latter would (like the current through a galvanometer coil) deflect a needle hung in the interior of the tube with its axis perpendicular to the tube when undisturbed, or it would magnetise a bar or wire of soft iron placed within the tube. The current itself would (except near the end of the tube) produce no external effect directly; but either of those appliances may be used to give an external indication. Experiments were made for Sir William by Mr. Macfarlane in the physical laboratory of the University of Glasgow on the last-mentioned plan; and on the former plan by Mr. J. T. Bottomley in the physical laboratory of King's College, London, by kind permission of Prof. Adams, and with the valuable assistance of his staff. Mr. Macfarlane, using a small mirror magnetometer suspended externally in the neighbourhood of one end of an iron wire placed within a brass tube, found that when the twist of the substance was right-handed the end of the wire next that end of the tube by which the current enters becomes a true north pole. Mr. Bottomley, with the cell and suspended mirror and needle of an ordinary dead-beat mirror galvanometer, supported by an independent support within a brass tube along which a current is maintained, found that the true north pole of the needle is moved towards the end of the tube by which the current enters. Thus both Mr. Macfarlane's and Mr. Bottomley's observations confirm the anticipation that the electric conductivity is least in the direction of greatest extension, and greatest in the direction of greatest contraction of the metal. The apparatus by which Mr. Bottomley had made his experiment was exhibited to the meeting. It included a mode of balancing the effect on the internal needle by placing a circular portion of the main circuit at a proper distance from it, the centre and plane of the circle being in and perpendicular to the axis of the tube. From a measurement of the distance from the centre of the circle to the needle, when the balance is obtained, the ratio of the maximum to the minimum conductivity can be calculated. For further information on this subject, see our account of the Physical Society's meetings in last number.

DURING the recent Epsom Races the wires between the Grand Stand and the Post Office were worked by Wheatstone's Automatic instruments duplexed. In one hour 219 messages were sent in one direction, and 139 in the other—358 in all. More could have been sent in the latter case had there been more to send. The messages were of the ordinary kind, and of the average length, and not mere "results." This is believed to be the largest number of messages ever sent on one wire in the same time.

TRAFFIC RECEIPTS.

Name of Co., with amount of issued capital, exclusive of preference and debenture stocks.	Anglo-American Co. £7,000,000.	Brazilian Sub. Co. £1,300,000.	Cuba Sub. Co. £160,000.	Direct Spanish Co. £116,379.	Direct U.S. Co. £1,103,420.	Eastern Co. £3,697,000.	Eastern Ex. Co. £1,997,500.	Gt. Northern Co. £1,500,000.	Indo-Euro. Co. £425,000.	Submarine Co. £338,225.	West Const America Co. £300,000.	Western and Brazilian Co. £1,398,200	West India Co. £883,210.
	£ a	£	£	£	£ b	£	£	£	£	£	£	£	£
May, 1878 ...	42,990	12,564	3,500	817	11,650	33,650	23,844	19,463	... ...	10,584	... ...	10,652	5,705
May, 1877 ...	45,420	12,378	4,109	972	17,370	46,309	25,445	18,427	... ...	11,048	2,170	10,534	7,507
†Total Inc. 1878	74,200	112	... ...	... ...	... ...	... ...	... ...	4,519	... ...	... ...	... ...	... ...	... ...
†Total Dec., 1878	... ...	... ...	426	400	3,950	11,968	2,861	... ...	... ...	1,519	... ...	2,291	1,555

a Amount accruing by arrangement with Direct Co. *b* Amount subject to arrangement with Anglo Co. † Compared with same period (five months) 1877.

(The figures in this Table are as accurate as it is in our power to make them, but we do not guarantee their correctness).

New Patents.

1882. "Improvements in telephones and in apparatus connected therewith."—J. F. BAILEY, (communicated by E. GRAY), May 10. (Complete).

1889. "Lighting ordinary coal gas jets by electricity.—A. R. MOLISON, May 10.

1913. "Cleaning grain of the pieces of iron contained therein by the use of magnets."—G. SCHAEFFER, May 11.

1917. "Improvements in transmitting and receiving electrical and telephonic excitations, and in the construction and use of the apparatus employed therein."—A. S. HICKLEY, May 13. (Complete).

1927. "Construction and application of electric apparatus."—P. JENSEN (communicated by A. J. B. Cance), May 14.

1932. "Improvements in galvanic batteries and electrical apparatus, and in the application thereof for producing novel theatrical effects."—W. SCANTLEBERRY, May 14.

1937. "Coating or covering electric telegraph wires."—W. ABBOTT, May 15.

1988. "Improvements in phonic wheels or in driving and regulating the speed of wheels by electricity."—P. LA COUR, May 17.

2003. "Apparatus for the generation and application of electricity for lighting, plating, and other purposes."—H. J. HADDAN, (communicated by C. Brush), May 18.

2096. "A hydro-electric brake applicable to all rotating and rolling machines, either stationary or moveable, and specially to railway trains."—W. MORGAN-BROWN (communicated by J. Sabatier and L. Pouget), May 25. (Complete).

2137. "Improvements in telegraph signalling apparatus for increasing the speed of working telegraph cables or long highly insulated aerial lines, which I call 'Trimmer's electro-magnetic arrangement.'"—F. TRIMMER, May 29.

ABSTRACTS OF PUBLISHED SPECIFICATIONS.

3404. "Door locks."—GERARD WENZESLAUS VON NAWROCKI, Berlin (communicated by Alphons Lemke, Aschaffenburg, Germany). Dated, Sept. 7, 1877. 10d. This consists in constructing new or modifying old locks, so that they can be opened from a distant place by means of electricity or air pressure. The bolt is withdrawn by being connected to one end of a double-armed lever, the other or lower end of the lever being connected to a pulling spiral spring. When the door is shut, this lower end is held down by a projection on the boss of another or detent lever which rests, in the case of an electric lock, against two electro-magnets, and is attracted by them when a current is passed through the coils, so as to liberate the bolt lever and open the lock. When the current stops, a spiral spring raises the detent lever. The keeper of the electro-magnet can be regulated by a set spring. In the pneumatic form of lock, the detent lever is sprung by a double-armed lever, which can be raised by a column of air in an india-rubber pipe. While the bolt lever pulls the latch out of the door post, another bolt is thereby thrown forward. This bolt has a wedge shaped nose, which, coming against a correspondingly formed projection on the post, causes the door to open. This bolt also serves to set the whole mechanism for the next operation when the door is slammed to, a spring on its tail pushing the bolt lever back again.

3469. "Generating and applying electricity."—J. L. PULVERMACHER. Dated, Sept. 14, 1877. 10d. This consists in designs for "galvanic chain bands," &c., in the construction of a portable galvanic apparatus for personal application, and in an automatic compensator galvanometer, which, by means of a set of points or teeth on the needle, inserts or takes out resistance from the circuit by making and breaking contact with mercury cups.

3487. "Electric telegraph apparatus."—L. A. BRASSEUR, and S. W. M. DE SUSSEX, Brussels. Dated Sept. 15, 1877. 4d. This consists in raising the inking armature of a Morse instrument by an electro-magnet, formed of a horse-shoe magnet fitted with soft iron pole pieces, having coils wound round them. This horse-shoe magnet acting through the soft iron cores attracts the armature, and holds it away from the electro-magnet. The coils of this magnet are in circuit with those of the electro-magnet in circuit with the line, in such a way that the line currents, while causing the latter to attract the armature, cause the former to repel it by temporarily reversing the polarity of the soft iron poles. *(Not proceeded with.)*

3549. "Telephones."—T. W. MANN (communicated by J. A. Briggs, Coconada, E.I.). Dated, Sept. 21. 2d. This consists in certain arrangements for a vibratory telephone, such as the employment of a sounding drum at each end of the medium of communication, which may be of galvanized iron wire, or a tube filled with water, &c., in a strained condition. *(Not proceeded with.)*

3552. "Constructing and arranging magneto-electric apparatus."—A. S. HICKLEY, Dated, Sept. 21, 1877. 6d.

This describes an improved means of generating magneto-electricity applicable to signalling and other purposes. To each pole of a permanent magnet, which is mounted horizontally in suitable bearings, insulated when necessary, is attached one end of a small bar of soft iron, the other end having attached thereto a vertical rod of the same metal which acts as a core to a coil of covered wire, through the centre of which it passes, and projects slightly above the top of the same. A bar of soft iron rests upon the tops of the two vertical rods, which are connected with the respective poles of the magnets, and forms an armature. This armature is attached to one end of a lever, the other end being capable of being depressed by means of a rod and stud, or other suitable contrivance; and when so depressed the lever turns on a pivot, and raises the armature off the tops of the vertical rods. To work the apparatus, the armature is raised, and electricity thereby generated in the coils.

3597. "Electric Telegraphs."—F. H. W. HIGGINS. Dated, Sept. 25th. 2d. This is designed to produce audible signals through submarine cables by causing a disc of iron, under the influence of a magnet, to give out a ticking sound on any alteration of the strength of a current flowing round the magnet. The latter would be an electro-magnet, and the line current, by the intervention of a condenser or an induction coil, would be made to intensify the ordinary power of the magnetism, thereby causing the disc to sound. Two discs might be employed to yield different notes in correspondence with the Morse alphabet.

3639. "Electric Telegraph Apparatus."—L. A. BRASSEUR and S. W. M. DE SUSSEX. Dated, Sept. 29th. 8d. This includes the improved Morse armature described above in patent No. 3487, and also describes a sensitive relay, consisting of two double-bobbined electro-magnets, placed pole to pole. Between the poles of these two opposed electro-magnets, a long soft iron lever or tongue is supported by two silk fibres from the same point of an upright rod or post. One end of this tongue abuts against the foot of this post and turns round it as round a pivot; the two fibres otherwise support the tongue between the poles. The other end of the tongue travels between contact points when the true current operates. To further increase the sensibility of the tongue the whole is enclosed in a copper box from which the air is exhausted.

Correspondence.

[We do not hold ourselves responsible for any opinions expressed by our correspondents.—ED. TEL. JOUR.]

THE WEST INDIA AND PANAMA TELEGRAPH COMPANY'S SERVICE. *

SIR,—An article appeared in your *Journal* in August, 1877, vol. 5, No. 108, and one also in *Cassell's Family Magazine* for January, 1878, entitled, "The Submarine Telegraph Service."

No one who has been in the Submarine Telegraph Service can do otherwise than support the statements of the writers of those two articles; and I now purpose to treat the same subject, particularly bearing on the West India and Panama Telegraph Company's Service. . . . . .

The first drawback to a clerk is that there is no scale of promotion in the service, all salaries being individual and not attached to office; this system damps any ardour or ambition, and throws the clerk into an apathy that is as detrimental to the company as it is to himself. It is as well that a proper explanation on this point should be clearly given. When the clerk-in-charge of a station, whose salary we will say is £320, resigns, or is dismissed, his second in office is raised to the clerk-in-chargeship, on a probation, which probation, unfortunately, may run over a couple of years, during which time his endeavour to prove himself worthy of the £320, has at the expiration of that time, to be disappointed with some flattering reply, to his application for increase of pay, by being told that the matter has been referred to the Board of Directors, which practically means that *it has been thrown into some pigeon-hole or waste-paper basket* never to be remembered, till the poor applicant is some months after compelled again to draw attention thereto, when he *may* get a trifling increase on his pay as a subordinate, notwithstanding the important fact that he is in charge of the office, and subject to all its responsibilities and impositions; and if it be possible for the superintendent to trump up any trivial shortcomings of his, to evade giving him such increase, he is frequently, on the face of his having endeavoured to do his best towards promoting the company's interest, compelled to leave the service as the company seem to have no appreciation of his services. The shortcomings of the clerks are visited by fines, and not unfrequently with reductions of pay or deprivation of promised increment.

It does not matter what interest a clerk may take in the service, his suggestions are simply carried out if practicable, and he only receives in recognition a flattering but evasive letter, and a promise which is as quickly forgotten, as it was written; a reminder of the same *may* be visited with the greatest indignation. His services are not taken into consideration, and carefully weighed against his shortcomings.

The appointment to a clerk-in-chargeship is made irrespective of length of service, intelligence, and practical and theoretical knowledge of the work; and this is scarcely to be wondered at when the General Superintendent goes through the stations, say but once in four years; he can thus have no practical knowledge of persons, and can only depend on the reports of a clerk-in-charge. These are not unfrequently partial, being at times unjustly injurious, or unduly flattering, to the party to whom it may refer, and if the party reporting has previously predisposed the General Superintendent favourably to himself, his influence may be prejudicial to the interest of subordinates. There are instances when the General Superintendent's opinion of the staff at stations is only formed from the correspondence of the clerk-in-charge about them, and those communications are far from being free from *prejudice*, *self-esteem* and *avarice*. In many instances personal advancement has worked rather an evil influence on the destinies of underlings.

The salaries of the clerks, already inadequate, both as regards their responsibilities and the expensiveness of the colony, are nevertheless subject to deductions for fines.

If the Telegraph Company desire to ensure the services of respectable, honest, and efficient servants, these must be properly paid. A clerk-in-charge in the most expensive colonies should be in receipt of £350, the second in office, £250, and so on down to £180, with annual increments of £10 and £5. The clerk-in-charge of a less expensive colony, where there may be less work, should get £200 per annum, with increment of £10, and his junior, £150, with £5 increment. This would command good and intelligent operators, and respectable men. By such a fixed scale of salaries, clerks will be ambitious in working up from £150 to even £250. It would also obviate the necessity of paying gentlemen in Trinidad, Demerara, and the Spanish and French islands as bankers or agents, as the salary could procure a gentleman to fill those important stations without the risk of embezzlements; and even as regards that, they might be made to give sufficient security to cover the probable receipts passing through their hands per month. The company needs no represen-

* We publish only those portions of this letter which have not a personal bearing.—ED.

tatives to the governments beyond the clerk-in-charge, as it can, with the Secretary of State for the Colonies in London, use all the influence required for its benefit. . . . . .

By having *gentlemen* at a salary to ensure efficiency and command respect, the entire administration would be more satisfactory, and the position as clerk-in-charge of a station would be looked upon by the public as important and trustworthy; it would invite confidence and ensure respectability.

It would not be amiss to throw out some suggestions with respect to the improvement necessary.

1st. The department of the General Superintendent to be lessened in cost.

The salary of the General Manager of Telegraphs in New Zealand, is only £650 and his accountants £350, yet this little company can afford to let their General Superintendent's department cost them over £2,300 per annum, to manage a couple of dozen petty stations, yielding a net revenue, exclusive of subsidies, of about £12,000 per annum, on a capital of £883,210.

2nd. There should be no assistant superintendent. . . . .

3rd. The agencies should be abolished, and respectable and efficient men, backed by proper security, employed as clerks-in-charge.

4th. The stations should all open at 6 a.m. and close at 6 p.m. on week days, and 7 a.m. to 10 a.m. on Sundays.

This would enable the staff to be reduced, and the remaining staff be made efficient, and *well paid*. There is not sufficient traffic to necessitate opening at nights, especially as the delivery of messages is unnecessary after 5 p.m., as the business places close at that hour.

The present staff is four or five at each large or transmitting station, and two at intermediate ones, inclusive of the clerks-in-charge. This could be reduced to three at the large or transmitting stations, and a couple of reserve clerks at St. Thomas for relief purposes.

5th. Each clerk should have at the expiration of three years' service, three months leave of absence on half pay. The clerk acting to receive the one-fourth, and the juniors the other fourth of the pay. In case of sickness, after three months on sick leave, clerk should resign on a gratuity of half his pay, for three months in full, provided he has served three years. Each clerk-in-charge should, after ten years' service, be entitled to a pension of one-third of his pay, and each junior one-fourth.

6th. That learners be accepted, giving a salary of thirty dollars per month for one year, and £150 after, provided competent. Each candidate to give satisfactory proof of having had a liberal education.

7th. That all the rules and regulations of the company should be dispensed with prudence and impartiality.

8th. The General Superintendent should make half-yearly visits through the stations.

9th. That the offices and fittings be improved, and the apparatus be of the best type.

10th. That all reports be searchingly investigated, and be dealt with impartially.

11th. No increments justly earned should be withheld.

12th. That the writing work of the offices be considerably reduced, or mechanical means afforded to make copies of the original records.

13th. For the increase of traffic and convenience of the public, that a *telegraph money order system* be established throughout the colonies, and between the colonies and Great Britain, charging one per cent., or any other reasonable rate of commission, besides the charge of ten words to wire the advice. To Great Britain the amount remitted should not be less than £100, and more than £1,000, and by this the company could realise a splendid revenue, as they could, through the General Superintendent, wire the advice to the Secretary in London in a code, and would thereby economise on the ten words charged for.

In order to avoid statements of a personal nature, it has been difficult to properly convey as full an idea of the present working of the company's business as might be desired. It is, however, hoped that this letter will be found practically useful, and that telegraph companies in general, and the West India and Panama Telegraph Company in particular, will understand that their object should not confine itself only to the dividends they can declare; but also to set a proper value on the services of their *employés*, so that they may be induced to consider the company's success as identical with theirs. To regard such services as mere mechanical drudgery has a most suicidal tendency: it results in the performance of the duties mechanically and without prospect, and renders the *employés* susceptible to every chance that offers for a change of employment. . . .

All reforms suggested herein can be effected without any increase of expenditure, and I can only forsee that from the revolution, profit and pleasure to all concerned, will be the inevitable result.

I am, Sir, yours, &c.

WEST INDIAN TELEGRAPHIST.

Proceedings of Societies.

PHYSICAL SOCIETY—8TH JUNE, 1878.

Professor W. G. ADAMS, President, in the Chair.

The following candidate was elected a Member of the Society, Mr. R. H. Solly.

The SECRETARY read a paper by Prof. Hughes on the "Physical Action of the Microphone." That instrument renders it possible to introduce into an electrical circuit an electrical resistance which varies in exact accord with sonorous vibrations, so as to produce an undulatory current of electricity from a constant source, whose wave length, height, and form is an exact representation of the sonorous waves. Professor Hughes has found that when an electrically conducting matter in the form of powder, filings, or superposed surfaces, is put under a certain slight pressure, far less than that which would produce cohesion, and more than would allow it to be separated by sonorous vibrations, a remarkable state of things occurs, the electrical resistance being caused to vary by rearrangements as regards the form, number in contact, or pressure of the molecules. It is essential that the instrument be so arranged as regards pressure between the touching surfaces as to be adapted to the particular vibrations employed: thus a box suitable for a man's voice is not adapted to observe the tramp of a fly. But in all cases a perfect undulatory current can be secured throughout a certain range; and, when speaking to the instrument, a galvanometer should be interposed in the circuit, and the pressure between the surfaces gradually increased from a minimum until the needle remains stationary, when a maximum of loudness will be attained; beyond this point the sounds die out gradually until there is complete silence.

Professor HUGHES then proceeded to consider the probable cause of the observed phenomena, taking as an illustration the very simplest form of instrument, two blocks held together by an insulated adjusting screw, the lower block being fixed to the board, by means of which it receives the sonorous vibrations. From numerous experiments he inclines to the belief that the whole block increases and diminishes in size at all points, both in the centre and at the sides, in accordance with the form of the sonorous wave, and that this increase in size varies the resistance by changing (1), the pressure at the surface of discontinuity, and (2) the extent of the molecular surfaces in contact. Of these changes he considers the latter has the greatest effect, since some of his best results have been obtained by using two surfaces of solid gold, and not

by such an elastic conductor as metallized silk, which would be most affected by the first-named change. As evidencing the great mechanical effect produced by this uprising of the molecules, he mentioned that, when a large musical box was playing, one ounce of lead did not suffice to maintain two surfaces of 1 sq. c. m. in contact until the box was placed several feet distant. Professor Hughes is now mainly anxious to find some efficient insulator for sounds, as, until such is available, it will be impossible to isolate and study many objects which require investigation from this new point of view.

Professor HUGHES himself then exhibited some of the remarkably simple appliances he has used in his investigations. A very small clock, placed on a small drawing-board which carried a microphone, was used to interrupt a current passing through a telephone, and the tick was immediately audible through the whole room. A very remarkable effect was then shown. The microphone attached to this board being still connected with the telephone, which, being provided with a bell-mouth, enabled the audience to hear the sounds produced, a second telephone was introduced into the circuit, and laid on the board, when a continuous sound was at once produced; this, Professor Hughes explained, would last as long as the battery continued in action, and its explanation is as follows: The act of placing the telephone on the board set up a vibration in the microphone; this passing to the bell-mouthed telephone was returned to the board, and set the second telephone in action, and again passed through its action to the microphone. Hence the action is self-supporting, and it solves in a most perfect manner the question of a relay for the human voice in telephony; for it becomes only necessary to provide such an arrangement at each station for a speech to be both received and transmitted to any number of succeeding stations. The system is perfectly duplex, for if two correspondents speak into microphones and use telephones for receiving, each can hear the other, but his own speech is inaudible, and if each sing a different note, no chord is heard. Experimenting on deaf persons, he finds that they can be made to hear the tick of a watch, but not human speech, and his results have led him to conclude that we only hear ourselves speak through our bones, and not through our ears. Finally, Prof. Hughes illustrated Sir Henry Thompson's method of probing for shots, splinters, &c., by finding a very small shot in the midst of a piece of wash leather.

SIR JOHN CONROY, Bart., M.A., read a paper on the "Light Reflected by Potassium Permanganate." After referring to the results obtained by Haidinger and Stokes, and more recently by Wiedemann, he proceeded to describe his own experiments which have been made by means of a very complete Babinet's Goniometer, provided with a vertical as well as a horizontal stage, so that the reflecting surface could be placed directly over the axis of the instrument. Sunlight unpolarized or polarized in any plane by a Nicol, was used, and the moving arm of the instrument carried a direct vision spectroscope with a "bright spot" micrometer and a reflecting prism for bringing a second spectrum into the field. The colour of a surface, obtained by rubbing the crushed permanganate into a surface of ground glass with an agate burnisher, was found to vary with the nature of the light and its angle of incidence, and it further varied as the surface was immersed in benzone bisulphide, or tetachloride of carbon. With light polarized perpendicular to the plane of incidence the dark bands of the reflected spectrum are far more distinct than when unpolarized or polarized perpendicularly to that plane. In the first of these three cases four bands are observed at angles less than 40°, and the blue end of the spectrum is very weak; as the angle of incidence increases the intensity of the blue rays diminishes. The dark bands gradually shift towards the blue end of the spectrum, and at about 60° a new band appears near D. With a still greater angle more of the blue rays are reflected, and the bands fade away, those in the more refrangible part disappearing first. This displacement amounts approximately to 0·006 tenth metre.

Professor S. P. THOMPSON exhibited and described a cheap and efficient form of optical bench. Two straight oak bars about two metres in length, are clamped together as in a lathe-bed, and a number of slides carrying various appliances slide easily without shake, and can be fixed in any position by wedges. The several frames carrying the diffraction grating or edges, the eye-piece (with an engraved glass micrometer) &c., are so made, in wood, as to be capable of adjustment in any plane, and the instrument can also be employed for making photometric measurements. The mean of two determinations for the wave length of certain red light gave 0·000629 as compared with Fresner's figure, 0·000640, while the total cost did not exceed £3.

The SECRETARY then read a paper by Prof. Ayrton, of the Imperial College of Tokio, Japan, on the "Electrical Properties of Beeswax and Lead Chloride." The index of refraction of the former substance increases in passing from the liquid to the solid state, and it therefore seems important, in connection with the electro-magnetic theory of light, to carefully measure the specific inductive capacity of a condenser made of wax, as it is cooled through its solidifying point. The rise in capacity, as the temperature falls from 80° C. to 60° C., is very striking, and the entire change was found to be in exact agreement with the changes known to occur in the index of refraction for light. An elaborate series of experiments was made which sufficed to show that the results obtained were not due to any change in the distance apart of the plates (of copper) between which the wax was placed, caused by any shrinkage of this wax on solidifying. In consequence of a remark of M. Buff that lead chloride behaves as a metal, Prof. Ayrton has studied it as a dielectric, and he found in every case a diminution of resistance by electrification; but as this result was not confirmed on subsequent experiment, the question was more fully investigated, when he found that with an electro-motive force under 1·75 volts, there is an increase in resistance, and above that amount there is a regular or irregular diminution. This limiting force is about that required to decompose water, and he concludes that the results obtained must be due to the damp contained in the lead chloride.

General Science Columns.

CONTINUOUS BRAKES.

PART II.

IN the recent report of the Royal Commissioners on Railway Accidents the following extract from a report by Captain Tyler, in 1874, is quoted:—"When a form of continuous brake can be decided upon, cheap in construction, simple in action, easily adjusted, not requiring frequent repair, not liable to get out of order, applied at the will of the engine-driver, and available in each part in the event of a train becoming suddenly divided, and with those numerous other properties that a good brake ought to possess, then a further great step will have been made towards safety and efficiency in railway working. But it must be admitted that there are many considerations involved, and many difficulties to be encountered; and it will be far better in the end that time should be afforded for fully discussing, testing, and improving to the utmost, the many systems of

brake-power advocated, than by any premature and general adoption of what may afterwards be found to be an inferior system, to create more or less a bar to urther improvement." These words which have been, to a certain extent, adopted by the Commission by including them in their report, clearly point to the general application of one class or description of brake by all the several railway companies of the United Kingdom. This is, indeed, a most important point, and will eventually be found to be so, wherever intercommunication takes place between different lines, and the carriages of one line are liable to be attached to trains belonging to other companies. This is now a very general practice, and there are few railways whose carriages do not constantly travel on other lines. It is clear, therefore, that unless one uniform system of brake be adopted for all lines, trains, when made up with carriages belonging to different companies, will be liable to have half their length fitted with one system, and the other half with another system of continuous brake, which cannot be worked together, and, in all probability, in this case the brakes on one portion would be wholly inoperative whilst so employed; and, at any rate, the power of automatic action throughout the train would be impossible under these circumstances. However, with a view to the selection of the best form of brake, a great number of different systems have, for some time past, been in operation—chiefly experimentally—on the several lines of railway. The Chairman of the Railway Companies' Association, writing to the Board of Trade in April, 1877, observed that, "As at present advised, it does not appear to the companies essential that one form of brake should be universally adopted, but with the view to secure a general interchange of practical knowledge on the subject, the experience gained by the companies is freely communicated to each other from time to time." In reply it was stated, "If by this it is meant that it is desirable to try every form of brake, and that it is not desirable by the exclusive adoption of one form to prevent the trial and introduction of better forms, the Board of Trade would entirely concur; but if it is meant that there would be no advantage in having one form of brake for all lines which interchange traffic with one another, the Board of Trade hold a different opinion; for it appears to them obvious that in the interchange of rolling stock, including ordinary carriages, saloon and family carriages, horse-boxes, carriage and fish trucks, and other vehicles forming part of passenger trains, between one line and another, if the brake fittings are not similar, the efficiency of the brakes must be proportionately impaired, and that this must be especially the case where the lines of two or more companies are continuous." The London and North Western, the Great Northern, and the Midland Companies all run through trains to Scotland, which are forwarded over the Caledonian, North-Eastern, North British, Glasgow and South-Western, and Highland Railways. It is, therefore, obvious that the advantage to be derived from any continuous brake system in use on any of these lines will be diminished and neutralized if at such stations as Carlisle, Glasgow, York, Edinburgh, Perth, and Inverness, the traffic is so arranged that carriages fitted with one system of brakes are attached to trains containing carriages fitted with a different system. This evil can only be avoided if those companies, which interchange traffic with one another, adopt one and the same general system. Before describing the different kinds of brake in detail, we extract from the published correspondence with the Board of Trade, particulars as to which brakes have been or are being tried by the several railway companies, and the opinions expressed by them so far as they have been formed from past experience of their working:—

Caledonian Railway.—Westinghouse Atmospheric; Westinghouse Automatic; Clark and Webb's; Steel and McInnes.

Glasgow and South Western.—Westinghouse Atmospheric and Smith's Vacuum Brakes.

Great Eastern.—Westinghouse Automatic; Smith's Vacuum; Barker's Hydraulic; Fay's; and Clark's Chain Brake.

Great Northern.—Westinghouse Automatic; Smith's Vacuum; and Clark's Chain Brake.

Great Western.—Smith's Vacuum; Sanders' Vacuum.

London, Brighton, and South Coast.—Westinghouse Automatic Brake.

London, Chatham and Dover.—Westinghouse Automatic Brake.

London and North Western.—Clark and Webb's Brake.

Midland. — Westinghouse Automatic; Smith's Vacuum; Sanders' Vacuum; Barker's Hydraulic, and Fay's Brake.

North British. — Westinghouse Automatic; and Smith's Vacuum Brake.

North Eastern.—Westinghouse Automatic Brake.

North London.—Clark's Chain Brake.

South Eastern.—Smith's Vacuum Brake.

It appears that the Westinghouse Automatic Brake is used on eight lines of railway; Smith's Vacuum on seven; Clark's Chain on three; Westinghouse Atmospheric, Clark and Webb's, Sanders' Vacuum, and Barker's Hydraulic, each upon two lines; and the Steel and McInnes, and Fay's Brakes each upon one line of railway. In order the better to enable some opinion to be formed of the relative merits of the principal brakes in use, a short description of each of them and of their several performances is appended.

(*To be continued.*)

THE great statue of "Liberty illuminating the world," which is destined to be placed as a lighthouse in New York Harbour, and is a present from the French Republic to America, is now finished, and will speedily be placed for a time at the entrance to the Paris Exhibition. The idea of this important work was

conceived in 1876, the year of the Centennial of American Independence, by several French admirers of America, and the expense has been shared equally by both countries. It will be erected on Bedloe Island, in the centre of New York Bay, in front of Long Island, where the first blood of the colonists was shed in the cause of liberty. The artist is M. Bertholdi. The figure represents Liberty holding aloft a flaming torch in the right hand, and grasping in her left the tablets on which are inscribed the Declaration of Independence. A diadem encircles her head, and by night it will become luminous, the spokes radiating electric beams which will light up the entire bay, and the buildings of Brooklyn, New York, and Jersey city. In height, the colossal statue is over one hundred feet, and will stand on a stone pedestal 82 feet high. It is made of copper plates fastened round a framework of iron. Instead of filling up the interior with masonry, to give stability to the statue, M. Bertholdi has lined it with compartments, which will be filled with sand. When masonry is employed, an accident often requires the demolition of the whole; but by this device the statue may be repaired by simply tapping the sand.

HEAT OF FLAME.—By means of a thermo-electric apparatus, M. Rosetti, of Venice, has made a determination of the temperature of the flame of a Bunsen burner. His results are as follows:—Exterior flame 1350° C., diminishing to 1200° C. at the dark central cone; interior of cone, top, 650° C.; interior of cone, bottom, 250° C.

WHITWORTH'S "IMPREGNABLE" IRON PLATING.—This formidable armour has been recently tried at Manchester. It is formed of Whitworth's fluid compressed steel, built up in hexagonal sections, which are composed of a series of concentric rings round a central disc; and is designed to guard against the cracking tendency of steel, by confining each crack to the ring it appears in. A Palliser shell weighing 250 lbs. was fired from a 9-inch gun, with 50 lbs. of pebble powder, at a range of only 30 yards from the target, which was 9-inches thick, and set against a backing of sand. This projectile would have passed through 12 inches of ordinary iron armour-plating, but burst harmlessly into innumerable fragments on striking the target, which, however, was driven 18-inches backward into the sand.

A French *savant*, M. Mouchot, has been making experiments in Algeria on the industrial application of solar heat. He collects the sun's heat by reflectors, preferably of brass, electro-plated with silver. The quantity of heat collected per minute by a reflector one square metre in area, is, at Algiers in May and June, about 8 calories. This quantity would boil in less than twelve minutes a litre of water at 20° C., and give 1322 litres of steam at the normal pressure of the atmosphere every hour. Small solar apparatuses for cooking, distilling, &c., have been introduced there successfully by M. Mouchot

HOLMES' INEXTINGUISHABLE SIGNAL LIGHTS.—These lights, which may be of great service at sea, are made by enclosing phosphuret of calcium in an air tight vessel under pressure, and, by means of an automatic arrangement, the duration and intervals of the signal flashes are controlled at will. The entry of the water to ignite the composition and produce the signal flame, is automatically regulated, as also is the escape of the phosphuretted hydrogen gas which results from the combustion. This apparatus has been recently patented by Mr. Holmes.

AGRICULTURAL LOCOMOTIVES.—In a paper read last February by Mr. Aveling, before the London Farmers' Club, and recently circulated, it is stated that the agricultural locomotives at present employed in this country represent in the aggregate 30,000 horse-power, and, with the machinery they drive, may be valued at £2,000,000. The object of the paper is to bring into notice the disabilities under which these locomotives labour, with a view to obtaining the sanction of the legislature to their removal. Mr. Aveling thinks that, in the country, the regulations concerning the consumption by the locomotives of their own smoke should be relaxed; that the man carrying a red flag in front of the engine should be dispensed with; that weak road bridges should be strengthened sufficiently to admit of the safe passage of locomotives, and that the hours during which they may travel should be unrestricted, except in large towns.

We think that due warning should continue to be given of the approach of road locomotives in country districts, as they cannot be avoided, like railways can, by persons driving young or timid horses; and, till these locomotives come into much more general use, it would be unfair to make the cost of strengthening the bridges fall upon the highway rates, especially as the roads suffer considerably from the passage of these engines, and the cost of repairs is hereby materially increased.

No fewer than six vessels—two Russian, one German a Swedish, a Dutch, and a Danish—left Europe last month for the Yenisei River by way of the Siberian Sea. The capabilities of this route for summer trade will be tested by them.

A NEW OZONE MACHINE.—Professor Leeds exhibited recently at the Stevens Institute, New York, a new machine for producing ozone in large quantities. Pure oxygen is cooled to zero temperature, then thoroughly freed from moisture, and afterwards passed through highly electrified tubes. The ozone thus produced displays intense chemical power, oxidising silver and bleaching indigo instantly.

THE first part of the new edition of Thomson and Tart's *Natural Philosophy*, so long looked for, will shortly be issued by the Clarendon Press.

THE Commissioners of Patents have determined to revise and reduce in size the series of indexes of the subject matter of English patents. A competition will be held on June 18, and six clerks will be selected for the work. Four of those selected must possess a satisfactory knowledge of mechanics, and two of chemistry.

City Notes.

Old Broad Street, June 12th, 1878.

THE holders of Telegraph Construction Shares will undoubtedly hope that the advance which has taken place, and which is naturally referred to in the June circular of Mr. William Abbott, may be "justified," whether the immediate cause is traceable or not traceable "to the fact that the Eastern Extension Telegraph Company have concluded an agreement with the Australian Government for the duplication of the company's line from Singapore." If, as it is stated, the projected cable to the Cape of Good Hope is shortly undertaken, the Telegraph Construction shareholders may have additional cause for jubilation.

But we do not wonder that Mr. Abbott alludes in somewhat dubious terms to his dearly loved West India and Panama Company. It is indeed a fact—almost a notorious fact by this time—that the traffic receipts of the company have shown a decrease during the months of April and May, 1878, as compared with April and May, 1877; and it is equally true that the shares have "consequently declined." Mr. Abbott does pluck up hope enough to aver that "there is every reason to believe that the decline will be but temporary, as any revival in trade will immediately have a favourable effect upon the traffic returns." Exactly. But it is the revival in trade that we cannot as yet, at any rate, be sanguine about. The outlook at the present moment rather drives us to a conclusion that we have not seen the worst of the general depression; and, if that be so, we are afraid that the trade of the West Indies will not improve as speedily as the shareholders of the West India and Panama Company, and Mr. Abbott, desire.

At the recent meeting of the shareholders of Reuter's Telegram Company, the chairman, Colonel Holland, remarked that on the last occasion it was his duty to move the adoption of the most unsatisfactory report which had been issued since the formation of the company. He then, however, ventured to predict that things would be more satisfactory a year hence, and we are glad to be able to coincide with him that he was not unduly sanguine. As we briefly mentioned in our last issue, the company has paid a dividend of 7½ per cent. and carried forward to the reserve fund a considerable amount of the sum which last year the directors were compelled to take from it in order to declare a dividend at all. Nor did the chairman, like some chairmen we could name, attempt to put too bright a face upon the prospects or present position of the company. He only contended that there was now no reason to complain of the latter, and that the report should also encourage them concerning the former. It is a matter for regret that Baron de Reuter, whose name, justly observed Colonel Holland, is a household word both in England and throughout Europe, has been compelled, on account of failing health to retire from the part of managing director, but the shareholders may be heartily congratulated upon the fact that his son, Mr. Herbert de Reuter, has been appointed in his place.

The directors of the Brazilian Submarine Telegraph Company have declared an *interim* dividend for the quarter ended March 31st, of 20s. 6d. per share, or 5 per cent. per annum, free of income tax. Perhaps the directors will excuse us for observing that they have not been in any hurry to declare a dividend. This is the middle of the third month of another quarter.

It is notified by the Eastern Extension Telegraph Company that the repair of their Singapore-Saigon Cable is completed. Messages can now, therefore, be forwarded to China and Japan by that route.

The following are the latest quotations of telegraphs: Anglo-American, Limited, 62-62½; Ditto, Preferred, 91½-92½; Ditto, Deferred, 34½-35½; Black Sea, Limited, 2-3; Brazilian Submarine, Limited, 6⅞-7; Cuba, Limited, 9¼-9⅜; Cuba, Limited, 10 per cent. Preference, 15¾-16¼; Direct Spanish, Limited, 1⅞-2¼; Direct Spanish, 10 per cent. Preference, 9½-10; Direct United States Cable, Limited, 1877, 13⅝-13¾; Eastern, Limited, 7⅛-7⅜; Eastern, 6 per cent. Debentures, repayable October, 1883, 105-108; Eastern 5 per cent. Debentures, repayable August, 1887, 102-104; Eastern 6 per cent. Preference, 11⅝-11⅞; Eastern Extension, Australasian and China, Limited, 7⅜-7⅞; Eastern Extension, 6 per cent. Debenture, repayable February, 1891, 106-109; German Union Telegraph and Trust, 8-8⅛; Globe Telegraph and Trust, Limited, 5⅛-5⅜; Globe 6 per cent. Preference, 10⅝-10⅞; Great Northern, 8⅜-8⅞; Indo-European, Limited, 20-21; Mediterranean Extension, Limited, 2⅛-3; Mediterranean Extension, 8 per cent. Preference, 9¼-9½; Reuter's, Limited, 10-11; Submarine, 221-226; Submarine Scrip, 2-2¼; West India and Panama, Limited, 2⅛-2⅜; Ditto, 6 per cent. First Preference, 8⅛-9; Ditto, ditto, Second Preference, 8¼-8⅜; Western and Brazilian, Limited, 5-5¼; Ditto, 6 per cent. Debentures "A," 98-101; Ditto, ditto, ditto, "S," 96-99; Western Union of U.S. 7 per cent, 1 Mortgage (Building) Bonds, 111-113; Ditto, 6 per cent. Sterling Bonds, 101-103; Telegraph Construction and Maintenance, Limited, 31-32; Ditto, 6 per cent. Bonds, 102-104; Ditto, Second Bonus Trust Certificates, 2⅜-2½; India Rubber and Gutta Percha and Telegraph Works, Limited, 24½-25½.

In the leading journal lately, attention has been directed to what our contemporary calls "the precarious position of the ordinary stock of our English railways," the position being due, our contemporary affirms, "to the want of system which has marked the treatment of their capital expenditure." We are compelled to admit that the case made out against the railway companies is decidedly damaging. Railway shareholders need not be panic-stricken at the facts and figures which the writer in the *Times* formulates; but, if they devote serious attention to them, it may be so much the better for them hereafter. Without doubt, many of the companies which pay the highest dividends are guilty of the sin of charging to capital what should be charged to revenue—and, sooner or later, Nemesis must overtake directors who allow such oose, not to say worse, account-keeping.

We had hoped that there would be no need for us to refer further to the London Chatham and Dover Railway Company. But it is usually amusing to hear the pot calling the kettle black, and a remark of one of the most furious opponents of the fusion scheme, that "it answered the purposes of adverse speculators to start a report that a large sum of money would be required to complete the Deal and Dover line, but, like most rumours of a similar nature, it has no foundation in fact;" it has, no doubt, been the cause of more than one smile. Possibly the "adverse speculators" were guilty of the sin laid to their charge, but what of the speculators who were not adverse, and whose purposes it answered and answers, to deny all rumours that are likely to affect the shares of the Chatham Company?